TORONTO AREA WATERSHED MANAGEMENT STRATEGY STUDY

INTERIM REPORT ON TORONTO AREA WATER QUALITY

April 1983

Reference

Ontario Ministry of the Environment
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TABLE OF CONTENTS

		Page
List of Tables		ii
List of Figures		iv
1.	Introduction	1
2.	Data Base	2
	2.1 Existing Data	2
	2.2 TAWMS Surveys, 1981	2
	2.3 Data Interpretation	3
3.	Results and Discussion	4
	3.1 Bacteria	4
	3.2 Nutrients	4
	3.3 Water Clarity and Conductivity	6
	3.4 Heavy Metals	6
	3.5 Trace Contaminants	8
4.	Conclusions	11
5.	Proposed TAWMS Activities, 1982-1986	13
References		14

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1. INTRODUCTION

The five-year Toronto Area Watershed Management Strategy Study (TAWMS) was initiated in 1981 by the Ministry of the Environment. Although wholly funded and managed by MOE, TAWMS receives extensive cooperation and support from the Metropolitan Toronto and Region Conservation Authority and from the Boroughs and Cities of the Municipality of Metropolitan Toronto. This multi-agency approach is vital to the success of the project and to the implementation of study recommendations.

The purpose of the study is to seek out locations in Toronto where water quality requires improvement, and to develop cost-effective measures for achieving that improvement. The study's overall goal is to produce a comprehensive water quality management plan for the Toronto area watershed, with particular emphasis on the Don and Humber Rivers and Mimico Creek. The TAWMS study area is shown in Figure 1.

This report summarizes work carried out in the first year of TAWMS which was directed towards a closer definition of existing water quality conditions within the study area. The work relied heavily on historical and recent water quality data collected through the routine sampling programs of MOE and other agencies, but also made use of information from a limited sampling program undertaken by TAWMS in 1981 to supplement the routine data base.

This report provides additional information which supplements the findings of the Ministry of the Environment's Central Region 1979 report "Water Quality Indices of Streams in the Ministry of the Environment Central Region", which was based only on 1978 data.

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2. DATA BASE

2.1 Existing Data:

The existing data base incorporated information from a number of programs within MOE. Most of the data are for conventional pollutants such as nutrients and bacteria; data for heavy metals and trace organics are only available for a few locations near the mouths of the Don and Humber rivers. The locations of routine program station are described in Table 1 and shown in Figures 1-4. Only data from 1978-1981 were utilized in this analysis to ensure that results are representative of conditions prevailing in 1981. 1978-1980 data were drawn from the Provincial Stream Quality Monitoring Network; 1980 data were derived from the MOE Enhanced Tributary Monitoring Program.

2.2 TAWMS Surveys, 1981:

A sampling program was undertaken by TAWMS in 1981 to supplement existing data, especially for heavy metals and trace organic contaminants such as pesticides and industrial chemicals. However, as some of these compounds are difficult to detect in water samples (because of low concentrations and insolubility), TAWMS also collected stream bed sediment and clam and fish tissue samples, both of which have been demonstrated to accumulate and concentrate a number of trace contaminants.

Two TAWMS surveys (September 25, 1981 and October 1, 1981) were conducted at twelve river and six sewage treatment plant effluent stations. The surveys were designed to represent baseline and storm conditions, respectively. All samples were analyzed for nutrients, metals and physical parameters such as turbidity; the storm samples were also analyzed for trace contaminants. TAWMS station locations are described in Table 1 and shown in Figure 1.

Bed sediment samples (top 5 cm) from special TAWMS surveys, collected using coring and dredge apparatus, were subjected to analyses for particle size and nutrient, heavy metal, PCBs, organochlorine and other pesticide concentrations.

Tissues from freshwater clams caged at 12 stations for 21 days were analysed for PCBs, organochlorine and other pesticide concentrations. Other biological monitoring involved the collection of juvenile fish from 9 locations in the Humber and Don rivers and analysis of their tissues for the same contaminants.

2.3 Data Interpretation

In reviewing the results of all surveys, it is important to note that up until approximately October, 1981, the Pugsley and North Don sewage treatment plants in Richmond Hill, and the John Street plant in Thornhill, were in operation and discharged their treated effluent to the Don River system. In the late fall of 1981, these plants were removed and their sewage flows directed to the York Durham sewer system for treatment at the Duffin Creek plant. The North Toronto plant is now the only remaining municipal sewage treatment plant discharging to the Don River.

All data presented in this report have been compared against Provincial Water Quality Objectives where possible. In some cases, where no objective or criterion has been defined for a parameter (often the case for trace organic compounds), the presence or absence of the contaminant has simply been noted.

3. RESULTS AND DISCUSSION

3.1 Bacteria:

All rivers in the study area were moderately to severely contaminated with coliform bacteria. Most stations in the three watersheds showed geometric mean total coliform bacteria densities which exceeded Provincial Water Quality Objectives for total body contact recreation. Fecal coliforms also exceeded objectives at all locations except for the headwaters of the Main Humber River (near Bolton), and the mouths of the East and West Humber rivers. As expected, individual concentrations of bacteria were extremely variable, especially at those stations downstream of storm sewers, combined sewer overflows, or sewage treatment plant (STP) discharges (where wet weather bypass of normal operation may occur). Geometric mean bacterial results are illustrated in Figures 2-7.

This bacterial contamination poses a potential public health hazard where people wade, swim or bathe and therefore curtails recreational use of the river waters.

3.2 Nutrients:

Total phosphorus levels were high throughout the study area, even in the headwater areas of the Humber and Don Rivers (see Figures 8-10 and Table 2). Concentrations exceeded the 0.03 mg/L guideline to avoid nuisance algae growth in streams, and exceeded 1.0 mg/L in upper German Mills Creek where the Pugsley Sewage Treatment Plant was located (Station 85-005, Figure 10). Filtered reactive phosphorus levels tended to be higher at river mouths than in headwater reaches and comprise anywhere from 5% to 94% of total phosphorus (Table 2). Higher

proportions of filtered reactive phosphorus (greater than 30-40% of total phosphorus) are typical of sewage treatment plant effluents and combined sewer overflows. The higher concentrations of this parameter in downstream reachesundoubtedly reflect the presence of these discharges in urbanized areas. Un-ionized ammonia concentrations were generally within the 0.02 mg/L objective for the protection of aquatic biota, except in areas known to receive STP discharges, stormwater runoff, or combined sewer overflows. Most often in violation of the objective for this parameter were the mouth of Black Creek and the Don River downstream of the confluence with Taylor Creek (Table 3).

In routine and TAWMS sediment sampling total phosphorus was always and total Kjeldahl nitrogen often in excess of MOE guidelines for the open water disposal of dredged material (Persaud and Wilkins, 1976). The results of these sediment sample analyses are presented in Tables 4 and 5.

High nutrient concentrations in sediments were often associated with high percentages of organic material in the sediment (expressed as loss on ignition), suggesting an organic source or sources of contamination such as stormwater runoff, combined sewer overflows, or sewage treatment plant outfalls. Analyses of sewage treatment plant effluents did in fact show very high concentrations of total phosphorus (although the measured values may not be representative of typical conditions; see note in Table 6), filtered reactive phosphorus, total Kjeldahl nitrogen, filtered ammonia, nitrate and nitrite (Table 6). These nutrient levels provide the potential for excessive plant growth wherever physical conditions are conducive to it. No data are yet available on the nutrient concentrations present in combined sewage and urban stormwater runoff so the importance of these sources in generating nutrient loadings to the stream remains uncertain at present.

3.3 Dissolved Oxygen

Limited routine dissolved oxygen monitoring carried out on the watersheds under daytime conditions has shown that dissolved oxygen concentrations in the study area generally meet the objective for that parameter. No additional monitoring was carried out as part of the TAWMS program, but special oxygen studies which will include both night and daytime data collection are planned in future phases of TAWMS.

3.4 Water Clarity and Conductivity:

Suspended solids concentrations were moderately high throughout the study watersheds (Table 2, Figures 11-13). The mouth of the Humber River (Station 83-001) and the Don River at Pottery Road (Station 85-014, about 4 km upstream of the mouth) exhibited the highest annual mean daily concentrations in the study area. Lowest levels were observed in the background Humber River station at Bolton. Turbidity measurements in the watersheds corroborated these observations, with highest turbidity usually found in the river sections farthest downstream (Table 2, Figures 14-16). This pattern would suggest that urban storm runoff and instream and bank erosion contribute suspended material to the streams.

Conductivity displayed patterns similar to those observed for nutrient and clarity parameters (Table 2, Figures 17-19). Highest conductance was seen in more heavily urbanized portions of the watersheds and lowest conductance in the headwaters of the Humber River. In general, conductance was highest during the low flow survey (September 25, 1981) and lowest during the storm survey (October 1, 1981), presumably because of dilution effects during high flows. Elevated chloride concentrations are sometimes responsible for high conductance; primary sources of chloride in urban areas are road salt in winter, and sewage treatment plant and combined sewer outfalls year-round. Large fluctuations and high winter chloride concentrations have in fact been measured in Toronto area rivers (Ralston and Hamilton, 1978) and it is believed that deicing salt is a large local source of that chloride.

3.5 Heavy Metals:

Heavy metals data, like data for trace organic compounds, were very limited for the Toronto watersheds. Most historic observations were for stations close to the mouths of the Don and Humber Rivers. At those stations, data were available for copper, zinc, lead, cadmium and mercury, but mercury results were for unfiltered samples and were difficult to interpret in light of the filtered-water criterion of 0.2 ug/L. Of the other parameters, copper and zinc most frequently exceeded the provincial water quality objectives, with cadmium and lead also occasionally in violation (Table 7). TAWMS sampling results showed similar patterns (Table 8). Chromium, which was also measured in the TAWMS program, showed no violation of objectives. Generally, heavy metal concentrations were higher in the Don than in the Humber River.

Routine surface bed sediment samples from two stations in the watersheds showed that copper, chromium, zinc, cadmium and lead approach or exceed MOE dredging guidelines at both stations monitored (Table 4). TAWMS sediment sampling revealed violations of the guidelines for those parameters only near the mouth of the Humber River and, for lead, at the mouth of Black Creek (Table 5).

Sewage treatment plant effluents entering the rivers were also observed to contain high concentrations of copper, zinc, cadmium and lead during both TAWMS surveys in 1981 (Table 9). As with other parameters such as nutrients, it is likely that the discharge of sewage treatment plant effluents into the streams, and storm runoff from urbanized areas, are largely responsible for heavy metal contamination in the receiving streams of the watersheds.

It should be noted that all these metals (copper, nickel, cadmium, chromium, lead and zinc) are widely used in the Great Lakes basin for a variety of industrial purposes, including

metallurgy and metal fabricating, manufacturing of electronics, pigments, paints and glazes, photography, lithography and the production of chemical products. The burning of fossil fuels, including coal, oil, and gasoline, releases quantities of heavy metals into the atmosphere and thus onto streets and other land surfaces, from which they may be washed into stream waters. The relative significance of these various sources in generating heavy metal loadings to the streams remains uncertain but will receive continuing investigation in future phases of TAWMS.

3.6 Trace Contaminants:

Routine and TAWMS monitoring programs in the study area showed that 14 PCB/organochlorine compounds of 22 analysed have been detected in river water samples (see Tables 10 and 11). A number of these compounds were found in concentrations exceeding provincial objectives. PCB's were the most commonly found contamina:, often in violation of the objective for that parameter. PCP (pentachlorophenol) concentrations only rarely occurred in detectable concentrations in the 1981 TAWMS survey. The compounds most frequently detected in river water samples were αBHC, γBHC (Lindane), and Dieldrin; γBHC (Lindane) and Dieldrin were both in violation of the provincial water quality objectives. Other parameters occurred with variable frequency. Of those with objective levels established, Heptachlor Epoxide and Endrin were found in concentrations higher than the provincial objectives in the single TAWMS survey.

However, it must be emphasized that most compounds were not detectable in water samples. Those not detected include Heptachlor, Aldrin, Mirex, αChlordane, γChlordane, oxy Chlordane, most metabolites of DDT, methoxychlor, all carbamates examined, all orthophosphate pesticides examined

except Diazinon, most triazine herbicides examined and most chlorophenoxy/chlorobenzoic acid herbicides examined (see Tables 11-15).

In general, the parameters found in detectable concentrations in the Toronto area streams were similar to those found in four other Ontario and nine U.S. urban river systems (O'Neill, 1979; EPA, 1982). Contaminant concentrations in all the Ontario and U.S. systems were observed to vary widely; this may be attributable in part to differences in analytical techniques among laboratories. However, it can be concluded that the Humber and Don Rivers and Mimico Creek do not differ significantly from other similar systems in terms of trace organic compound contamination. It is difficult to make direct comparisons between river systems, since the particular set of contaminants found in any one system is probably largely dependent on the industrial mix in the system watershed.

(Note that no MOE objectives now exist for αBHC, PCP, 2,4,5-T and many other compounds. The reader is referred to the MOE publication Water Management Goals, Policies, Objectives and Implementation Procedures (November, 1978) for details of guidelines.)

Sediment samples taken throughout the watersheds in routine and TAWMS monitoring revealed detectable concentrations of PCBs, $\sum$DDT, $\sum$BHC, $\sum$Chlordane and Heptachlor Epoxide at a very few sites, notably the mouth of the Humber River. Thiodan II (Endosulfan) was also found in the Humber River at several sediment sampling locations. However, as with water samples, most compounds were not detected at most stations (Tables 16 and 17).

*Note: "$\sum$" implies "total".

Clams (Elliptio complanatus) left caged in the study area for three weeks concentrated detectable levels of PCBs, Σ DDT, Σ Chlordane, Heptachlor Epoxide and α and γ isomers of BHC). Other compounds less commonly found were HCB, Thiodan I and Dieldrin (see Table 18).

Young-of-the-year fish collected from stations in the three watersheds also had accumulated detectable concentrations of PCB's, Σ DDT, Σ BHC and Σ Chlordane (Table 19). Lowest concentrations in the fish tissue were observed in those samples obtained from the less urbanized section of the Humber River at Finch Avenue, while the highest concentrations were found in heavily urbanized areas such as Black Creek and the Don River. Table 19 shows that several species were used in the 1981 surveys, depending on location (some species were not found at some locations). Caution must therefore be used in comparing data from one species to another until differences (if any) in the bioaccumulation mechanisms of the species are more closely defined.

Upstream of the mouth of the Humber River, only common shiners were collected; in that stretch, very high levels of PCBs were noted at the Scarlett Road site (F4), suggesting the possibility of a source of PCBs there. It should also be noted that a significant decline was observed from 1977 to 1979 in PCB residues in spottail shiners from the mouth of the Humber River (Suns et al., 1981). 1977 levels approached 2200 ng/g, dropping to about 1200 ng/g in 1979. Table 19 demonstrates a further reduction in 1981 to about 950 ng/g.

Finally, it must be emphasized that most of the trace contaminants discussed above have been monitored for fewer than five years, so it is difficult to assess trends over time.

4. CONCLUSIONS

Recent water quality data from the Don and Humber Rivers and Mimico Creek demonstrate that the urbanized portions of those watersheds exhibit the poorest water quality. The Don River and Mimico and Black Creek watersheds are almost entirely urbanized at present and show the most degraded water quality overall. The West and Main Humber Rivers exhibit relatively good water quality at stations farthest upstream, but with increasing distance downstream, progressive water quality deterioration is apparent. In general, sediment and biological tissue samples corroborate findings from water samples, although more trace organic compounds were detected in sediment and biota than were found in water samples. However, because the data base for heavy metals and trace organic compounds is so limited in areal and temporal extent, conclusions about the nature and implications of data for those compounds must be considered only tentative at present.

The following paragraphs summarize the conclusions formulated from the Phase I work.

1. Bacterial densities throughout the urbanized portions of the watersheds indicate continuing contamination of surface waters, to the extent that body-contact recreation often must be restricted at locations in the watersheds.

2. Nutrient concentrations throughout the watersheds indicate continuing enrichment of stream waters. This situation can potentially endanger aquatic life by promoting the growth of nuisance algae.

3. Suspended sediment and turbidity measurements indicate that substantial erosion is ongoing in the watersheds, both from instream processes and from sheet erosion carried by surface runoff.

4. Conductivities are high in urbanized portions of the watersheds, indicating substantial contributions of dissolved salts and minerals there; these probably arise in large part from urban runoff during storm events.

5. Copper, zinc, cadmium and lead in the rivers were often found at concentrations in excess of water quality objectives and in sediment at levels above guidelines for the open water disposal of dredged material. The extent of their occurrence in the study area is not yet well documented.

6. PCB's and organochlorine, triazine and chlorophenoxy/chlorobenzoic acid compounds were detected in water, sediment and biological tissue samples throughout the study area. In some samples at some locations, parameters with established objective levels were observed in excess of those levels. Most trace organic compounds for which water quality analyses were performed were found in low concentrations or were not detected. Sediment samples also showed undetectable levels for most compounds at most stations.

   The limited data base available for these contaminants does, however, preclude the drawing of firm conclusions about their sources and pathways in the study area. However, the contaminants found in the Toronto area rivers appear similar to those observed in four other Ontario and nine U.S. urban river systems. Additional data to be collected in future phases of TAWMS are expected to shed light on this issue.

5. PROPOSED TAWMS ACTIVITIES, 1982-1986

1. Because the water quality in the rivers was observed to be worst in urbanized areas, future TAWMS activities will focus on those portions of the Don and Humber River and Mimico Creek basins within Metropolitan Toronto boundaries (i.e., south of Steeles Avenue).

2. Particular attention will be directed to further study of pollutants which are of most concern for public health reasons (i.e., bacteria), which are most persistent in aquatic systems (i.e., trace organic compounds), or whose distribution and severity of contamination in the study area are least well known (i.e., trace organics and heavy metals).

3. TAWMS activities will be divided into "source" studies of outfalls and other sources of contamination, and studies of the receiving stream waters. All TAWMS activities in the watersheds will be coordinated with ongoing waterfront monitoring programs.

4. Research efforts will be directed primarily to the abatement of water quality problems. Urban stormwater runoff, combined sewer overflows and sewage treatment plant effluents appear to have particular significance in the impairment of receiving stream water quality, especially with respect to bacteria, nutrients and heavy metals.

5. Water quality sampling programs will be designed to monitor and characterize sources such as storm flows, spring runoff from snowmelt, and individual effluents. In particular, a comprehensive effort will be undertaken to pair water quality sampling with hydrologic sampling under a variety of flow conditions to evaluate loadings of pollutants as well as their instantaneous concentrations at a particular location. This will aid in assessing the relative importance of each source in determining receiving water quality.

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